# Export platform FDI and firm heterogeneity

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**Abstract**

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**Keywords:** Export platform; FDI; Firm heterogeneity; Trade costs

**JEL classification:** F21; F23

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## 1. Introduction

The literature on multinational enterprises (MNEs) has extensively investigated the role of market size, trade barriers, and wage costs in explaining the location of overseas production by multinationals (Markusen, 2002). When MNEs conduct market-seeking foreign direct investment (FDI), the host market size and trade costs are crucial determinants. When MNEs engage in efficiency-seeking FDI, labor costs determine their plant location. The former is often called horizontal FDI (HFDI), and the latter vertical FDI (VFDI). As compared to HFDI and VFDI, recent research has increasingly focused on "export platform FDI" in which MNEs export to third markets from offshore production. In this type of FDI, host countries' labor costs and their trade costs with third markets play a central role.

This branch of research is motivated by the growing importance of platform-FDI activity. For instance, export sales accounted for over 40% of total sales by foreign affiliates of Japanese MNEs in 2009, and export sales to third markets represented over 30% of the export sales (The 2010 Survey of Trends in Business Activities of Foreign Affiliates by the Ministry of Economy, Trade and Industry).[1] Despite its empirical importance, there have been few studies on export platform FDI. Eckholm et al. (2007) consider three types of export platform FDI according to the destination market of the overseas plant. "Home-country export platform" refers to the MNEs' activity in which their foreign plant exports to the home market; "third-country export platform" refers to a foreign plant that exports only to a third market; and "global export platform" refers to a foreign plant exporting to both home and third markets. Other previous studies have examined these FDI types.[2]

This paper extends the literature by decomposing the traditional platform FDI into pure platform FDI (PFDI) and complex platform FDI (CFDI) and explicitly analyzing the role of firm heterogeneity in these FDI choices. These FDI types are similar in terms of supplying products only to a third market, and can be called third-country platform FDI. MNEs engage in PFDI by locating their plants in one host country and conducting all stages of production there. On the other hand, MNEs pursue CFDI by maintaining

[1] A similar share of exports to third countries can be observed also in the case of the U.S. multinational firms (Eckholm et al., 2007).

[2] For instance, the global platform is equivalent to the export platform in Baltagi et al. (2007), (S, S) production in Grossman et al. (2006), and (HSS) production in Aw and Lee (2007). The export platform in Blonigen et al. (2007) and (H, HS) production in Grossman et al. (2006) are included in the third-country platform. Lastly, the home platform can be taken as the union of vertical FDI and horizontal FDI. The framework in Yeaple (2003) is different from that in these studies because he considers the case in which overseas plants produce intermediate goods and supply them globally. The export platform in Mrazova and Neary (2011) is to set up one overseas plant and to supply its products to not only that host country but also neighboring third countries.

their plants in two host countries and engaging in vertical division of labor in terms of production process between those two plants by splitting production stages.

Our definition of PFDI is equivalent to the third-country platform proposed in Eckholm et al. (2007), whereas the mechanics of CFDI have not been examined in the literature. Furthermore, CFDI is not only a conceptually possible type of FDI activity, but empirically relevant. For instance, Japanese affiliates in Mexico tend to export their products mainly to third markets, perhaps the U.S. Also, Japanese affiliates in the U.S. have increased their third-market sales from 8% in 1995 to 18% in 2006.[3] If their main market destination is Mexico, this trend is consistent with the conceptual definition of CFDI. Possibly, Japanese affiliates in the U.S. may export intermediate inputs to other affiliates in Mexico for final assembly, and import the final products back to the U.S. market.

Our theoretical investigation provides several implications for the role of firm-level productivity in explaining the choice of different FDI types, including HFDI in which firms serve only one host market via local production. Specifically, the order of firms' productivity among FDI types changes between high and low trade costs. In the case of low trade costs between two potential host countries, CFDI firms should have higher productivity than HFDI and PFDI firms in order to cover the large fixed entry costs of setting up multiple offshore plants. In the case of high trade costs, the most highly productive firms are likely to choose HFDI.

We empirically examine these predictions about third-country platform FDI by focusing on Japanese FDI in the U.S. and Mexico. These two countries have some country characteristics consistent with the condition in which third-country platform FDI from Japan could occur. As such, we define PFDI as the FDI type in which Japanese firms have affiliates in Mexico, but not in the U.S. If they maintain affiliates only in the U.S., such FDI is defined as HFDI. Additionally, CFDI refers to the FDI when Japanese firms have affiliates in both Mexico and the U.S. In order to investigate the role of trade costs between two host countries, we take the signing of the North American FTA (NAFTA) as a chance for drastic reductions in trade costs. Specifically, we provide some evidence for the prediction by separately examining the productivity order among FDI types before and after the signing of NAFTA.

Our paper differs from a vast number of studies on firm heterogeneity in identification strategy for self-selection effects on FDI. Since the latter half of the 1990s, self-selection mechanics in firms' international activities have received enthusiastic

[3] These numbers are calculated using the RIETI FDI Database 2010: http://www.rieti.go.jp/en/database/FDI2010/index.html.

attention in the field of international economics. Melitz (2003) is the theoretical pioneering study on the selection mechanism in firms' exporting, and theoretically demonstrates that exporting firms should have relatively high productivity. The Melitz model has also been applied to firms' outward investing by Helpman et al. (2004), showing higher productivity of multinational firms over exporting firms. This proposition, i.e., the selection of investing, has been empirically tested by several papers (see, for example, Greenaway and Kneller, 2007). For identification, previous studies restrict the sample to domestic firms and firms that invest abroad for the first time. Self-selection effects are attributed to productivity differences between domestic firms and investing firms before making FDI. Such analysis isolates learning-by-investing effects from ex-ante productivity inherent to the firm, making it possible to focus on the impact of firms' inherent efficiency on investment decisions.

However, the causal analysis of self-selection mechanics in third-country platform FDI, particularly CFDI, is more difficult than in other types of FDI examined previously. While most of the prior work examines the self-selection effects for single-plant FDI, we need to analyze FDI activity associated with multiple offshore plants. The difficulty is that CFDI firms maintain two overseas affiliates, which are usually not set up at the same time. Thus, firm-level productivity would contain the learning effects from the first foreign plant if we compare its productivity after setting up the first affiliate and before setting up the second affiliate. To isolate the learning effects, we examine those Japanese firms that have no affiliate or only an affiliate in the U.S. in a given year, but maintain affiliates in both the U.S. and Mexico for a sufficiently late year. Comparing these Japanese firms with the firms that invest only in the U.S., we attribute their productivity differences to self-selection effects on CFDI. To the best of our knowledge, this paper is the first to explore the role of firms' productivity in third-country platform FDI and to analyze self-selection effects for a multi-plant type of FDI.[4]

The rest of this paper is organized as follows. Section 2 theoretically demonstrates firms' choice of FDI type. Section 3 explains data sources and describes the characteristics of Japanese FDI according to different FDI types. Section 4 conducts an econometric analysis of theoretical implications on the order of firm productivity among FDI types. We draw some conclusions in section 5.

[4] Aw and Lee (2008) and Yeaple (2009) examine the role of productivity in a multi-plant type of FDI. However, those papers compared firms' FDI status in a given year with their productivity in that year, namely a simple correlation analysis. Thus, investors' productivity contains the learning effects through investing abroad.

## 2. Theoretical Analysis

This section examines the condition in which heterogeneous firms determine complex integration strategies for HFDI, PFDI, and CFDI. It should be noted that the aim of this section is not to provide a general equilibrium model of multi-production stages and multi-country operations, but simply to obtain insights into the driving forces behind firms' choices of FDI patterns in a partial equilibrium model.

### 2.1. Profit Functions in Each Strategy

Suppose that there are three countries: home country and two potential host countries. The host countries are called "North" and "South". We assume that finished products are horizontally differentiated, for which each of a continuum of firms manufactures a different brand. For simplicity, the finished products are assumed to be consumed only in North.[5] A representative consumer in North has a constant elasticity of substitution (CES) function over varieties. As is well known, under the CES utility function, demand for the variety $k$ in country $i$ is derived as: $x_i(k) = p_i(k)^{-\sigma} A$, where σ is the elasticity of substitution between varieties with σ > 1. $p_i$ ($k$) is the price of the variety $k$ produced in country $i$. The brand name $k$ is omitted hereafter for brevity. $A \equiv P^{\sigma-1}Y$, where $P$ is the price index and $Y$ is total income in North. Although the demand level $A$ is endogenous to the industry, it is treated as exogenous by producers because every producer is of negligible size relative to the industry size. There are iceberg trade costs $t_i$ (≥1) for the shipment of finished products from country $i$: $t_i = 1$ if country $i$ is North and $t_i = t$ if country $i$ is South. As mentioned later, since the products are supplied by firms in either North or South, not the home country, trade costs are either unity or $t$.

The market structure of the finished product sector can be regarded as monopolistic competition. Finished products are produced in two stages of production. The production function in each stage is kept as simple as possible in order to highlight the interdependence of different production stages. Our Leontief-type production structure is as follows: a first-stage product is produced using $\theta$ units of skilled labor; a second-stage product is produced using one unit of the first-stage product and $\theta$ units of unskilled labor.[6] In other words, our production structure implies that products of each stage are used in fixed proportions, as there is no substitutability between both stages of

[5] As mentioned later, the assumption of costly trade costs in both intermediate and finished goods makes the analysis quite complicated. Thus, as in Grossman et al. (2006), we assume no demand in South. Nevertheless, our results do not change even if finished products can be consumed also in the home country.

[6] Assuming different input coefficients of production factors between products does not change our results qualitatively. For instance, if it is assumed that more than $\theta$ units of unskilled labor are necessary to produce a second-stage product, its production is more likely to be conducted in South.

products. Furthermore, an improvement in cost efficiency decreases the production factors used to produce each stage of product in the same proportion.

Factor prices for skilled and unskilled labor are represented by $r$ and $w$, respectively. Once again, there are iceberg trade costs $t$ for the shipment of the first-stage product between North and South. For the sake of simplicity, it is assumed that trade costs are identical between the first- and second-stage products.[7] If firms produce either or both the first- and second-stage products in North (South), they must incur plant set-up costs $f_N$ ($f_S$). For example, when firms produce the first-stage product in North and the second-stage product in South, they need to pay $f_N + f_S$.

By assuming that $w_N \geq w_S$ and $r_S \geq r_N$, we consider the production pattern of firms with headquarters at home. It is assumed that the headquarters cannot be relocated. In this paper, we are interested in three specific patterns[8]: HFDI (*H*), PFDI (*P*), and CFDI (*C*). HFDI is the production pattern in which firms produce the first- and second-stage products in North and supply finished products (i.e. the second-stage products) domestically. In PFDI, firms produce both stages of products in South and supply finished products from South to North. Lastly, CFDI is the pattern in which firms produce the first-stage product in North and the second-stage product in South, and supply finished products from South to North. We can rule out another complex type of platform FDI in which firms produce the first-stage product in South and the second-stage product in North because it is less profitable than HFDI due to the assumptions on relative factor prices.[9]

Among the three patterns, firms choose the pattern which yields the highest total profit. Let $c^M$ be a marginal cost in the production pattern $M$ ($H$, $P$, or $C$). Then respective marginal costs are given by:

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[7] Distinguishing trade costs between two stages makes the analysis quite complicated, and the examination of such a model is beyond the purpose of our empirical analysis; for such a model, see Grossman et al. (2006). However, it is worth noting that their model does not yield our PFDI and CFDI due to their assumption of identical trade costs among country-pairs. In this paper, we assume different trade costs between the Home-North pair and the South-North pair, which make these FDI types more profitable.

[8] Strictly speaking, we need to impose more assumptions to rule out other possible production patterns. Additional assumptions are that North has the same factor prices as home, and that fixed costs $f_N$ and $f_S$ are low enough, compared with iceberg trade costs between Home and North. These assumptions rule out the possibilities that firms supply their first/second products produced at home to North/South. The exclusion is due to our focus on firms' choice among only FDI types, not including exporting from home. Furthermore, even if we assume that the finished products produced in North/South can be consumed also at home, firms produce those products for the home market in the home country under these assumptions.

[9] This type of complex platform FDI can be most profitable if we change the order of factor prices between North and South to the opposite order and the production factor used in each stage of product.

$$c^H = (r_N\theta + w_N\theta),\qquad c^P = (r_S\theta + w_S\theta)\,t,\qquad c^C = (tr_N\theta + w_S\theta)\,t.$$

The profit-maximizing strategy yields $p_i = \sigma c_i^M/(\sigma-1)$, so profit functions are represented by:

$$\pi^H = (r_N + w_N)^{1-} A\,\Theta - f_N,$$
$$\pi^P = (r_S + w_S)^{1-\sigma} A\, t^{1-\sigma}\,\Theta - f_S,$$
$$\pi^C = (tr_N + w_S)^{1-\sigma} A\, t^{1-\sigma}\,\Theta - f_N - f_S,$$

where $\Theta \equiv (1\text{-}\sigma)^{\sigma\text{-}1}\,\sigma^{\text{-}\sigma}\,\theta^{1\text{-}\sigma}$. We call $\Theta$ the productivity measure. Since $\sigma > 1$, the smaller cost efficiency $\theta$ implies a larger value of productivity measure $\Theta$.

## 2.2. FDI Choice

This subsection examines which production pattern the firms at home choose according to their productivity levels. Let $S^M$ be the slope of the profit function in production type $M$. Then the three slopes are represented by:

$$S^H = (r_N + w_N)^{1-\sigma} A,\quad S^P = (r_S + w_S)^{1-\sigma} A\, t^{1-\sigma},\quad S^C = (tr_N + w_S)^{1-\sigma} A\, t^{1-\sigma}.$$

Immediately, we can obtain the following corollaries:

**Corollary 1.** $S^H \geq S^P$ iff $t \geq (r_N + w_N)/(r_S + w_S)$.

**Corollary 2.** $S^C \geq S^P$ iff $t \leq r_S/r_N$.

**Corollary 3.** $S^C \geq S^H$ iff $t\,(tr_N + w_S) \leq (r_N + w_N)$.

These corollaries can be further summarized as follows:

**Corollary 4.** *Suppose that* $(r_N + w_N)/(r_S + w_S) > r_S/r_N$. *Then,* $S^H > S^P > S^C$ *iff* $t > (r_N + w_N)/(r_S + w_S)$, *and* $S^C > S^P > S^H$ *iff* $t < r_S/r_N$. $S^P \geq S^C$ *and* $S^P \geq S^H$ *iff* $r_S/r_N \leq t \leq (r_N + w_N)/(r_S + w_S)$.

**Corollary 5.** *Suppose that* $(r_N + w_N)/(r_S + w_S) < r_S/r_N$. *Then,* $S^H > S^P > S^C$ *iff* $t > r_S/r_N$, *and* $S^C > S^P > S^H$ *iff* $t < (r_N + w_N)/(r_S + w_S)$. $S^P \geq S^C$ *and* $S^P \geq S^H$ *iff* $r_S/r_N \leq t \leq (r_N + w_N)/(r_S + w_S)$.

To illustrate a profit line for each FDI type with the profit level on the vertical axis against productivity, we need to know the orders of the slopes among FDI types and fixed costs between North and South. Based on the above discussion, the order of the slopes can be summarized as follows. As is clear from Corollaries 4 and 5, the medium range of trade costs suggests that the slope of PFDI is always the highest, but it is ambiguous whether or not the slope for HFDI is steeper than that for CFDI. In the high range of trade costs, we have an ordering of $S^H > S^P > S^C$ whereas the ordering is $S^C > S^P > S^H$ in the low range of trade costs. To simplify our analysis, we focus on the high and low ranges of trade costs hereafter. However, we do not know the order of fixed costs. For example, from an empirical point of view, it remains unknown whether Japanese firms have lower fixed costs for local production in the U.S. or Mexico. Thus, we consider both the cases of $f_N > f_S$ and $f_S > f_N$.

Before showing the figures of profit lines, it is worth pointing out three crucial determinants of FDI type: differentials in factor price, trade cost, and fixed cost between North and South. First, wage differentials for skilled and unskilled labor between North and South increase the benefit from vertical division of labor by production stage, which encourages firms to choose CFDI. Second, the large trade costs between North and South discourage the CFDI type because firms incur trade costs twice, i.e. those for transporting the first-stage product from North to South and those for transporting the second-stage product from South to North. Since firms choosing PFDI pay trade costs for shipping the second-stage product from South to North, the choice of PFDI is also discouraged in the case of high trade costs. Lastly, the lower fixed costs in North and South encourage firms to choose HFDI and PFDI.

Taking factor prices as given, we can depict four kinds of figures according to trade costs between North and South and the order of fixed costs between them.[10] As shown in Figure 1, in the case of low trade costs and lower fixed costs in North, firms in the medium range of productivity choose PFDI, and those in the high range of productivity choose CFDI. The reason is that low trade costs encourage firms to choose CFDI. However, CFDI needs the highest fixed costs, which deter less productive firms from choosing it. Since the low trade costs also decrease the burden of trade costs in PFDI that has smaller fixed costs than CFDI, less productive firms tend to choose PFDI. However, PFDI also needs relatively higher fixed costs than HFDI because of the lower fixed costs in North, so firms in the low range of productivity will choose HFDI.

=== Figure 1 ===

As shown in Figure 2, in the case of low trade costs and lower fixed costs in

[10] We assume that profit lines interact at a positive level of profits. In any of the figures, firms with the lowest range of productivity do not locate their affiliates overseas, and do not supply their products through exporting from home. Also see footnote 8.

South, firms with relatively high productivity are able to choose CFDI while those with relatively low productivity choose PFDI. The underlying logic in this case is basically the same as previously mentioned. On the other hand, PFDI requires lower fixed costs than HFDI, so all firms that are not able to choose CFDI will pick PFDI. As a result, no firm will choose HFDI.

=== Figure 2 ===

The cases of high trade costs are explained as follows. Figure 3 shows that in the case of lower fixed costs in North, all firms choose HFDI for the expensive operation in South due to the high trade costs and the higher fixed costs in South. In the case of lower fixed costs in South as shown in Figure 4, high-productivity firms follow HFDI whereas low-productivity firms choose PFDI. HFDI is chosen by productive firms that can earn sufficient profits to cover the relatively high fixed costs in North. Since high trade costs prevent firms from choosing CFDI, the relatively less productive firms follow PFDI. In sum, high trade costs encourage firms to choose HFDI.

=== Figures 3&4 ===

As a result, our simple theoretical examination gives us the following testable hypotheses, which will be subject to empirical investigations[11]:

**Hypothesis 1.** *Assume that wages for skilled and unskilled labor are lower in North and South, respectively. When trade costs between North and South are low enough, low-productivity firms choose HFDI. Medium-productivity firms follow PFDI, and high-productivity firms pick CFDI.*

**Hypothesis 2.** *Assume that wages for skilled and unskilled labor are lower in North and South, respectively. When trade costs between North and South are high enough, high-productivity firms pursue HFDI while low-productivity firms choose PFDI.*

[11] Although we assume that firms need to pay $f_N$ and $f_S$ in choosing CFDI, total fixed costs in the case of CFDI may be less than $f_N + f_S$. Nevertheless, it seems to be natural that such total fixed costs are at least greater than $f_N$ or $f_S$. In this case, even if we assume that total fixed costs in CFDI are less than $f_N + f_S$, our results above do not change qualitatively at all; rather, it expands the productivity range of firms choosing CFDI.

## 3. Data Description

This section provides an overview of outward FDI activity in Japan, using the data on overseas affiliates of Japanese companies from Toyo Keizai's *Overseas Japanese Companies Data*. This dataset has been widely used in the literature, including Head and Ries (2002) and Cieślik and Ryan (2009). The Toyo Keizai conducts an annual survey on around 6,000 Japanese business enterprises that are either listed or not listed on the stock market and maintain at least one foreign subsidiary. Information on the overseas affiliates includes their location, investment year, investment type (new establishment, capital investment, and acquisition), amount of capital, total number of employees, number of employees, earnings, main lines of business, purpose of investment, and funding relationship with their parent firm(s). The overseas affiliates in the sample are defined as those in which a Japanese firm has invested capital of 10% or more.

In order to focus our analysis only on the FDI types considered in the theoretical section, we restrict the sample to overseas affiliates in the U.S. and Mexico. Specifically, we define the firms choosing HFDI as those that have affiliate production not in Mexico, but in the U.S. The firms for PFDI are those that have affiliate production not in the U.S., but in Mexico. Lastly, the firms for CFDI are those that have affiliate production in both the U.S. and Mexico.

These two countries meet at least three assumptions on host-country characteristics imposed in the previous section. First, we assume $w_N \geq w_S$ and $r_S \geq r_N$. We should interpret this assumption under the condition that labor quality is similar in the U.S. and Mexico. If a firm in Mexico employs skilled labor with the same education level as that in the U.S., they will incur higher costs for searching for qualified workers in Mexico due to a lack of skilled labor. This suggests that the total cost per skilled labor in Mexico is likely to be more expensive than that in the U.S. Second, we assume that Home and North have the same factor prices. In our sample, Japan is the home country for the firms with affiliate production in the U.S., suggesting that the second assumption is reasonable when Japan and the U.S. have almost the same level of factor prices. Lastly, we assume that $f_N$ and $f_S$ are low enough as compared with trade costs between Home and North. This assumption is sensible because the U.S. and Mexico are geographically distant from Japan, as compared with, for example, East Asian countries.

We examine the hypothesis by comparing the orders of parent-firm productivity among FDI types before and after a decline in trade costs between North and South. To this end, we take the signing of NAFTA in 1993 as the cutoff period for which trade costs between the U.S. and Mexico started to decrease substantially. Calculating ad-valorem trade costs from the U.S. import data by Feenstra (1996), we find that trade costs including both duties and freight rate were 6.09 percent on average across the manufacturing industry in 1990, with a standard deviation of 4.35. In 2000, the average trade costs declined to 2.43 percent with a standard deviation of 2.02.[12]

While declines in ad-valorem trade costs vary substantially by industry, trade costs between the U.S. and Mexico decreased significantly between 1990 and 2000. Motivated by these facts, we interpret our hypothesis as suggesting that firm productivity should be the highest for the HFDI type in 1990 and for the CFDI type in 2000. This suggests that productivity is the highest for the Japanese firms that had foreign affiliate(s) only in the U.S. in 1990, while it is the largest for the Japanese firms that had foreign affiliates in both the U.S. and Mexico in 2000.

Table 1 tabulates the number of all firms classified by each FDI type, together with the number of firms that are listed on Japanese stock markets. The table shows that there are few PFDI firms for both all and listed firms. In the case of listed firms, there were only two firms classified as PFDI in 1990, and there were no firms in 2000. From a theoretical point of view, the small number of PFDI firms would point to the extremely small productivity range in which PFDI firms have the highest profits, meaning that wages for skilled workers in the U.S. are much lower than those in Mexico. Indeed, the U.S. is endowed more abundantly with skilled labor than Mexico. Therefore, PFDI is less likely to yield the highest profit for Japanese FDI in this region.

Another interesting observation is that the number of CFDI firms remarkably increased from 1990 to 2000, as compared with HFDI and PFDI firms. This could reflect the fact that the signing of NAFTA resulted in a significant change in trade costs between the U.S. and Mexico. As illustrated previously, an increase in CFDI firms is more pronounced than that in PFDI firms because CFDI requires firms to pay trade costs twice, but PFDI firms pay only once. Thus, the drastic reduction of trade costs between those two countries significantly increased the firms' profits in the case of CFDI, encouraging domestic, HFDI, and PFDI firms to conduct CFDI. These mechanisms could partly account for the fact that the number of CFDI firms tripled from 41 in 1990 to 112 in 2000.

[12] Following Bernard et al. (2006), we measure ad-valorem trade costs at the industry level from product-level U.S. import data compiled by Feenstra (1996). As imported products are classified according to the Harmonized System (HS) at the 10 digit level since 1989, we make a concordance between the HS code and industry classification of Japanese-owned foreign affiliates. For industry i and time t, we define ad-valorem trade costs as the sum of tariff and freight costs over customs import value: where fob is the free-on-board value and cif is the cost + insurance + freight value.

=== Table 1 ===

Next, we compare firms' productivity by FDI type. This paper estimates total factor productivity (TFP) for parent firms to measure their productivity. One sensitive issue for the TFP estimates derived from production function estimation is how to deal with unobserved productivity shocks. If they are correlated with unobservable input variables, simple OLS estimates will be biased. To address this endogeneity issue, we apply the method proposed by Levinsohn and Petrin (2003). This method uses intermediate inputs as a proxy for unobservable productivity shocks and obtains a consistent estimator of TFP. To this end, we use the data on firms' real gross output, real capital stock, and labor inputs from the database of "East Asian Listed Companies (EALC)" provided by Fukao et al. (2009)[13]. Because we use this database, our sample for productivity comparison is restricted to listed firms.

Table 1 reports the average and standard deviation of firms' TFP by FDI type. As confirmed above, the number of PFDI firms is too small to compare their productivity with the productivity for other types of firms. By restricting to the average TFP for HFDI and CFDI firms, we can see that CFDI firms have on average a higher TFP than HFDI firms do in both 1990 and 2000. However, the result in 1990 is not necessarily consistent with our theoretical prediction that HFDI firms should have the highest productivity before the reduction of trade costs, possibly due to omitted determinants of productivity. To address this issue, we conduct an econometric analysis in the next section.

## 4. Econometric Analysis

This section presents a formal econometric analysis for a comparison of firms' TFP across FDI types. Then, we proceed to identify a self-selection effect of firm productivity on the FDI types.

### 4.1. Conditional Productivity Comparisons

In this analysis, we restrict the sample to the Japanese firms categorized as HFDI, PFDI, or CFDI firms. The small number of PFDI firms forces us to combine PFDI and CFDI firms, which can serve as a benchmark set of firms for productivity comparison. Our estimating equation is specified as follows:

[13] The data is available at the Japan Center for Economic Research (JCER) web site: http://www.jcer.or.jp/report/asia/detail3735.html#database. Details of the measurement methodology and results are provided in Fukao et al. (2009).

$$\ln \text{TFP}_i = \beta_0 + \beta_1 \text{ HFDI}_i + \beta_2 \ln (1 + \text{Foreign Experience Years}_i) + \text{u}_s + \varepsilon_i.$$

$\text{TFP}_i$ is firm $i$'s TFP, and $\text{HFDI}_i$ takes unity if firm $i$ has affiliates in the U.S. but not in Mexico. The positive sign of $\beta_1$ implies that measured productivity is on average higher for HFDI firms than PFDI and CFDI firms. Additionally, we control for differences in knowledge/experience in international activities across firms by including the number of years from each firm's first FDI in any region. We expect that longer experience in foreign business is positively associated with firm productivity. Foreign Experience Years are the sample year minus the entry year of the parent firm's first foreign affiliate, calculated using Toyo Keizai's "Overseas Japanese Companies Data". Finally, we control for unobserved time-invariant differences in firm productivity across industry by including industry fixed effects, $\text{u}_s$.

Table 2 reports the OLS estimation of the above equation for years 1990 and 2000 separately. Our central hypothesis is that relatively more productive firms would choose HFDI during the period with high trade costs between the U.S. and Mexico whereas relatively less productive firms would pursue HFDI during the period with low trade costs between these countries. The expected coefficients for the HFDI dummy variable are positive in 1990 and negative in 2000. The results show that the HFDI dummy has significantly negative coefficients in both years, supporting the prediction in the year 2000. According to our estimates, third-country platform firms had 0.4% and 0.7% higher productivity than HFDI firms in 1990 and 2000, respectively. Thus, our analysis provides some evidence consistent with theoretical predictions on the order of firm productivity across FDI types when trade costs are relatively low. Finally, the years of overseas experience have significantly positive coefficients in both years. This result indicates that higher TFP may be necessary to have longer experience, or that longer experience may raise firms' TFP.

=== Table 2 ===

As in Table 1, HFDI firms did not have the highest productivity in 1990, i.e. a period of high trade costs, even in the comparison of firms' productivity *conditional on* firm and industry characteristics. However, these results must be interpreted with caution for at least two reasons. First, the regression analysis does not show any causal relationship between firms' productivity and their choice of FDI type. Because productivity comparisons are made from a cross-sectional point of view, the self-selection effects of firm productivity on FDI choice are not strictly disentangled from learning-by-investing effects. Our estimates for the relative productivity of HFDI firms could reflect both of these effects. Second, our empirical assumption for higher trade costs in 1990 may not be strictly consistent with the theoretical setting. High trade costs are an important condition in which more productive firms choose HFDI. Although we show a decline in ad-valorem trade costs between the U.S. and Mexico between 1990 and 2000, it is possible to interpret that the trade costs were already low for the year 1990. Unfortunately, the lack of data does not allow us to examine the older period when trade costs should have been much larger.

## 4.2. Identification of Self-selection Effects

This section explores the selection effects of investing, i.e. order of firms' *inherent productivity* in investment decisions. Up to this point, our measure of productivity in the previous analysis contained both firms' inherent productivity and learning-by-investing effects. However, the productivity measure in the theoretical setting does not take into account learning effects on productivity, so we need to disentangle firm-level inherent productivity from such effects. In the case of traditional FDI types, the previous papers often use firms' productivity one or a few years before their timing of making investments. However, such a comparison may not be applicable to our case because CFDI firms do not necessarily locate their two production plants simultaneously, i.e. in the same year. CFDI firms may locate their second plant several years after locating their first plant. In this case, the use of firms' productivity a few years before setting up the second plant contains the learning-by-investing effects from the setup of the first plant. In short, it is not easy to examine exclusively firms' inherent productivity level in the case of FDI with multiple foreign affiliates.

Our identification strategy for selection effects is as follows. We focus on a productivity comparison between HFDI and CFDI. Let (X, Y) be firms who are categorized into FDI type, X, in period $t-1$ and Y in period $t$. The time interval between these two periods is made long enough. Then, we compare productivity in the period $t-1$ between firms categorized into (None, HFDI) and (None, CFDI). In this comparison, the productivity in the period $t-1$ does not contain the learning-by-investing effects because in that period the sample firms do not have any affiliate in either the U.S. or Mexico. Specifically, we set $t-1$ at year 1985 for the analysis. In order to compare differences in the productivity order between high and low trade costs, we set $t$ as the period 1985–1992 for high trade costs and as the period 1994−2006 for low trade costs. For example, if firms that have no affiliate in the U.S. and Mexico for 1985 invest in both countries during the period of 1985–1992, these firms are categorized into (None, CFDI). For the analysis of high trade costs, we compare these firms' productivity in 1985 with the productivity of firms that invest only in the U.S. during the period of 1985–1992.

Based on this strategy, we estimate the probit model in which a dependent variable takes unity if firms are categorized into (None, CFDI) and zero if they are categorized into (None, HFDI). The independent variables are firms' TFP in 1985 and the Foreign Experience Years. The results in Table 3 show that there are no significant coefficients in both TFP and Foreign Experience Years. In particular, the sample size is very small in the case of high trade costs. The reason is that there are no firms categorized into (None, CFDI) in some industries, for which observations are dropped due to the perfect prediction by industry dummy variables. However, even with a relatively large number of observations in the case of low trade costs, the coefficient for TFP is still insignificant. Also, the results for the Foreign Experience Years indicate that longer experience in overseas activities does not have a significant impact on firms' choice between HFDI and CFDI.

=== Table 3 ===

We also make another comparison between (HFDI, HFDI) and (HFDI, CFDI). HFDI might be the optimal choice for firms in the case of high trade costs between the U.S. and Mexico. However, if the trade costs are significantly reduced, CFDI turns out to be a better choice particularly for the HFDI firms with high productivity. Especially, we assume that the learning-by-investing effects are not heterogeneous in firms' ex-ante productivity. That is, the productivity improvement effects through setting up the first plant in the U.S. (i.e., HFDI) have the same magnitude among HFDI firms. This assumption implies that the difference in HFDI firms' productivity in the initial period, i.e. year 1985, does not include the differences in learning-by-investing effects of HFDI, but is due solely to their inherent productivity differentials. Under this assumption, the productivity comparison between (HFDI, HFDI) and (HFDI, CFDI) also enables us to explore the causal relationship between firms' productivity and their choice of FDI type.

The results of probit estimation are provided in Table 4. As compared with the case of Table 3, this comparison gives us a sufficient number of sample observations. The results show that Foreign Experience Years have significantly positive coefficients, suggesting that longer experience in overseas activities encourages firms to change their FDI type from HFDI to CFDI. Additionally, the expected contrast between two equations can be seen from the TFP levels. In a period of high trade costs, all HFDI firms including productive HFDI firms stay in the status of HFDI. However, in a period of low trade costs, the productive HFDI firms change their FDI status to CFDI. This result is consistent with our expectation based on the theoretical analysis in Section 2. Thus, the more productive firms are more likely to conduct CFDI than HFDI.

=== Table 4 ===

## 5. Concluding Remarks

This paper investigated theoretically and empirically firms' productivity ranking among HFDI, PFDI, and CFDI. Our theoretical illustration shows that CFDI firms have highest productivity when trade costs between host and sales-destination markets are low. In the empirical analysis, HFDI and PFDI are defined as investment in either the U.S. or Mexico, respectively. The CFDI firms are defined as those that have production affiliates in both the U.S. and Mexico. Since few firms are categorized into PFDI in the case of Japanese FDI, our analysis on self-selection focuses on the productivity comparison between CFDI and HFDI. Based on an econometric analysis, we found that our hypothesis is consistent with the estimation results for a period of low trade costs, whereas the results for a period of high trade costs do not show the highest productivity of CFDI firms.

Our results yield a policy implication for low-wage countries seeking to attract foreign investment. It has been believed that one of the most important policies for attracting foreign investment is to reduce the trade costs with potential investing countries. However, we show that the reduction of trade costs with those neighboring large market countries matters for the investment decision by firms. MNEs with relatively high productivity may locate their production plants in low-wage countries by relocating some production stages from the sales market. In sum, our results indicate that it is important for low-wage countries to reduce the trade costs with not only investing countries but also neighboring large market countries, in order to attract MNEs, particularly those with high productivity.

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Table 1. A Comparison of Productivity between Horizontal and Platform FDI Firms

| | 1990 | | | 2000 | | |
|---|---|---|---|---|---|---|
| | HFDI | Platform FDI | | HFDI | Platform FDI | |
| | | PFDI | CFDI | | PFDI | CFDI |
| Number of All Firms | 1,593 | 11 | 73 | 2,012 | 18 | 215 |
| Number of Listed Firms | 469 | 2 | 41 | 628 | 1 | 112 |
| Ave. TFP | 8.54 | 9.37 | 8.98 | 9.03 | 8.69 | 9.77 |
| S.D. | 1.32 | 0.33 | 1.28 | 1.36 | n.a. | 1.53 |

*Note*: TFP is estimated by the Levinsohn-Petrin estimation approach with Grid search.

Table 2. Regression Results of Productivity Differences: HFDI versus PFDI/CFDI

| | 1990 | 2000 |
|---|---|---|
| HFDI | -0.416** | -0.713** |
| | (0.189) | (0.127) |
| Log of Foreign Experience Years | 0.349*** | 0.391** |
| | (0.059) | (0.092) |
| Industry Dummy | Yes | Yes |
| Number of Observations | 509 | 713 |
| R-squared | 0.43 | 0.21 |

*Notes*: The dependent variables are firms' TFP, which is estimated by the Levinsohn-Petrin estimation approach with Grid search. Figures in parentheses are robust standard errors. ***, **, and * show 1%, 5%, and 10% significance, respectively.

Table 3. Probit on Self-selection: No FDI before 1986 (Marginal Effect)

| Dependent variable (= 0 if HFDI, = 1 if CFDI) | (I) No FDI before 1986 HFDI or CFDI for 1989-1992 | (II) No FDI before 1986 HFDI or CFDI after 1994 |
|---|---|---|
| LP TFP in 1985 | 0.0001 | 0.003 |
| | (0.004) | (0.012) |
| Log of Foreign Experience Years | 0.012 | 0.003 |
| | (0.028) | (0.022) |
| Industry Dummy | Yes | Yes |
| Number of Observations | 52 | 173 |
| Pseudo R-squared | 0.18 | 0.08 |

*Notes*: Figures in parentheses are robust standard errors. ***, **, and * show 1%, 5%, and 10% significance, respectively. The sample firms are restricted to those who did not have any affiliates in both the U.S. and Mexico before 1986.

Table 4. Probit on Self-selection: HFDI before 1986 (Marginal Effect)

| | (I) | (II) |
|---|---|---|
| Dependent variable | HFDI before 1986 | HFDI before 1986 |
| (= 0 if HFDI, = 1 if CFDI) | HFDI or CFDI for 1989-1992 | HFDI or CFDI after 1994 |
| LP TFP in 1985 | 0.003 | 0.040** |
| | (0.004) | (0.018) |
| Log of Foreign Experience Years | 0.012** | 0.069** |
| | (0.006) | (0.034) |
| Industry Dummy | Yes | Yes |
| Number of Observations | 264 | 317 |
| Pseudo R-squared | 0.09 | 0.09 |

*Notes*: Figures in parentheses are robust standard errors. ***, **, and * show 1%, 5%, and 10% significance, respectively. The sample firms are restricted to those who invested in the U.S. but not in Mexico before 1986.

Figure 1. Profit Lines: Low Trade Costs and Lower Fixed Costs in North

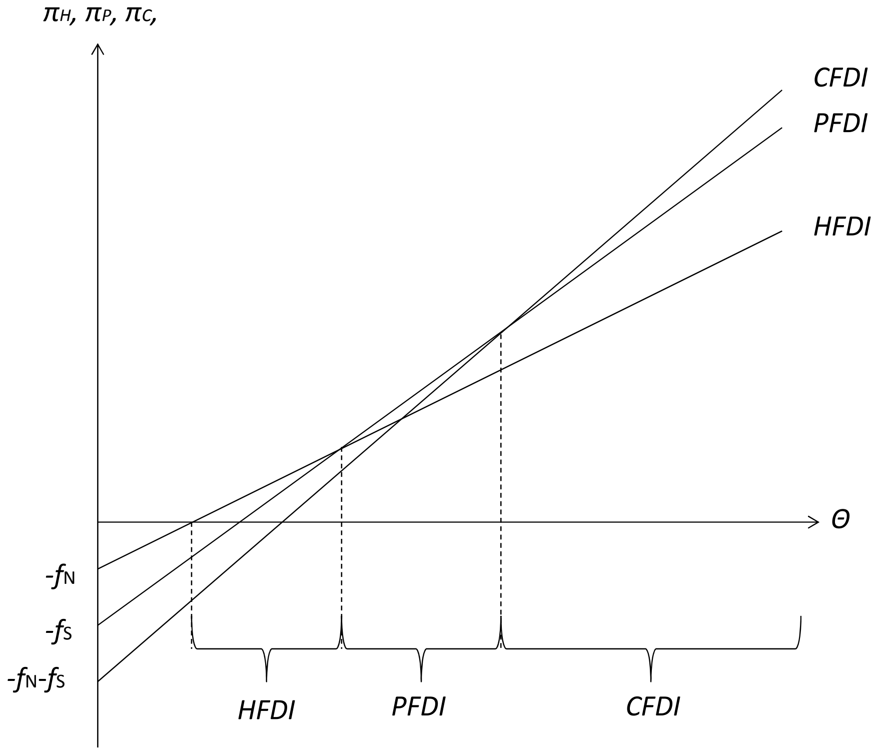


Figure 2. Profit Lines: Low Trade Costs and Lower Fixed Costs in South

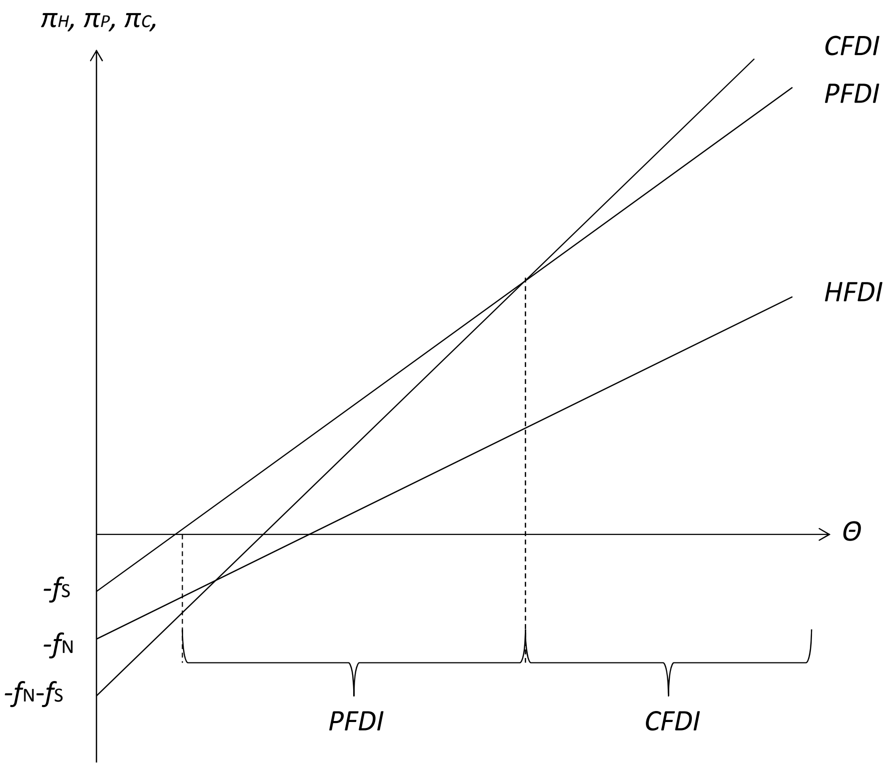

Figure 3. Profit Lines: High Trade Costs and Lower Fixed Costs in North

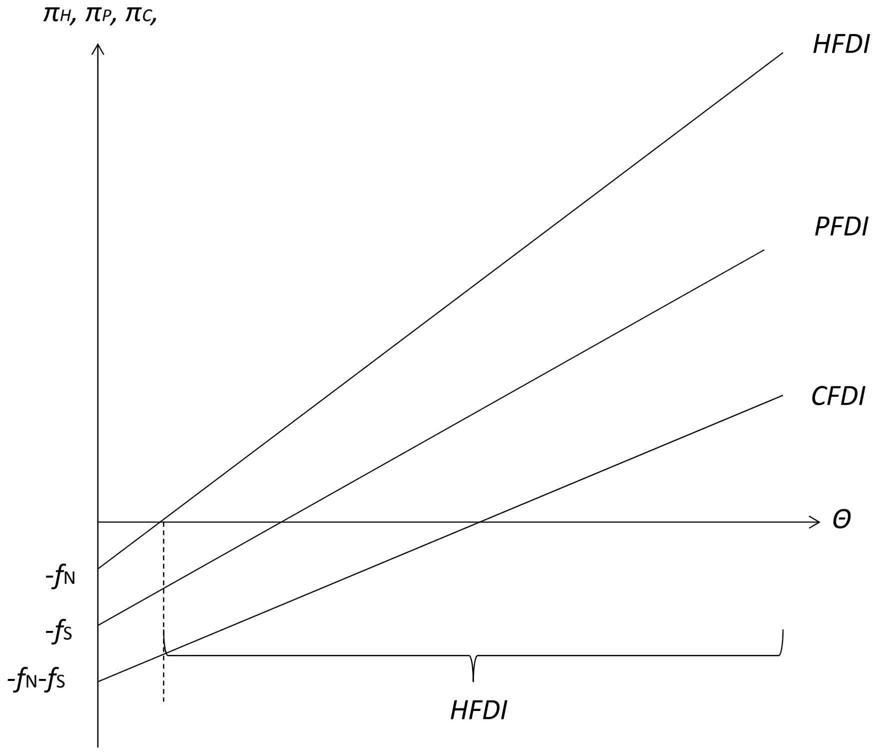


Figure 4. Profit Lines: High Trade Costs and Lower Fixed Costs in South